FRESHWATER BIOLOGICAL ASSOCIATION

FBA Translation (New Series) No. ..170.

Title: Profillotungen in Seen des schleswig-holsteinischen Jungmoränengebietes mit einem 30 kHz Sediment-Echolot.

(Profile soundings in lakes of the younger morainal area of Sleswick-Holstein with a Sediment-echo-sounder of 30 kHz)

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Reference: Wass. Boden 26, 135-138

Original language: German.

Date of publication of original: May 1974.

Translator: Ulrike Berninger.

Date of publication of translation: 1986.

No. of pages of translation: 7.

FBA TRANSLATION (NEW SERIES) NUMBER 170

Profile soundings in lakes of the younger morainal area of Sleswick-Holstein with a sediment-echo-sounder of 30 K-hertz.

MÜLLER, H.E. 1974

Wässer und Boden, 26 (5), 135-138

Translated by: Ulrike Berninger

1. Problem

To be able to carry out physical, chemical and biological investigations on a lake, one needs a thorough knowledge of the volume of water and the shape of the lake basin.

The main reason that the amount of stress our small and medium-sized lakes can take is often overestimated is that there is not enough knowledge about the morphological situation underneath the water surface.

Most of the available information on depths and profiles of lakes in Sleswick-Holstein is based on studies carried out in the 1920's and often derives from sources which are not very reliable (private fishermen etc.)

Because at that time advanced techniques were not used, the results do not actually give any information about the morphology of the lake and its ecological consequences.

With a few exceptions (Witternsee, Selenter See, parts of the Grosser Plöner See) none of the lakes in Sleswick-Holstein have had echo sounder profiles taken.

Due to a very high frequency of sounding an echo sounder gives accurate and absolutely complete information about the depth profile. Echo sounding has been used in our lakes recently, but in most cases this was just for limnological or fisheries purposes rather than for morphological ones. Morphological profiles using echo sounder techniques have been used more frequently in oceanography than in limnology.

W. Ohle (1, 2, 3, 4) investigated the considerable changes in the metabolism of lakes from East-Holstein, which cause a great increase in sedimentation and as a result in land reclamation. In this paper the present configuration of the lake basin is examined as a basis to draw quantitative conclusions on the metabolism.

2. Methods

A 30 KHz echo sounder with sediment transceiver was used to carry out profile determinations (echo soundings). This apparatus continuously records on paper the different reflexions and absorptions of the sediment and water body in the corresponding depth.

By this, acoustically noticeable layers and different densities in the sediment and 'scattering layers' in the water body due to physical, chemical and biological reasons (e.g. plans and single fish) are made visible.

Because of sharp concentrations of sounds and very short durations of impulses (ca. 0.4 x 10-3 sec.) the resolving power at the given frequency is high enough to differentiate between layers which are only very thin (few cms.). For the profiles shown the echo sounder was set as follows:

depth:	A, I (0-24m)
sediment emphasising:	6-7
velocity of sound	1440 m s-1
paper release	3

All other functions were adjusted in such a way as to receive an optimal quality and accuracy of recording without any effects of resonance.

The echo sounder (220v, 50 Hz, power: 120 W) is supplied with electricity by a portable electricity generator (Honda, type E 300). The magnetostrictively working nickel resonator (which is the transmitter as well as the receiver of the echo sounder) is attached to the boat outboards. Boats available at the lake were used. The boats were run with an outboard engine because a consistent speed was necessary to obtain a consistent horizontal scale. Course and speed were controlled using fixed points on the shore.

3. Results

3.1 Bathymetrical maps

example: longitudinal and horizontal profiles of the morphologically simple basin of Blunker See (East Holstein), fig. 1, 2.

First of all the required distances between single isobaths are chosen. (It is possible to choose very small distances because of the high frequency of soundings.). Then the profiles are transferred geometrically into the scale required for the map and so they can be used as a basis for constructing the bathymetrical map (fig. 3).

3.2 Sedimentation

Of special significance for the longitudinal profile of the echographs of the Blunker See is the area around P3 (see also fig. 2, P3). There is a lateral transport of sound near the shore because of water currents induced by the wind. The sand is accumulated underneath the water surface up to a certain maximum slope. If that slope is exceeded the sand starts sliding down and, due to its higher specific weight, it gets underneath that layer which appears at the upper layer on the echograph (fig. 2, P3). In situ this process of "under layering" is made visible by a sediment echo sounder.

3.3 Formation of gas and hypolimnetic O_2 metabolism

Carrying out the echo soundings in Blunker See something very interesting has been noticed for the first time, and further attention will be drawn to it. There appear lighter zones between the upper sediment echo and another underlying reflexion horizon in certain areas of the profile. This is especially obvious in P3 and P4 and between P7 and P8. After the sediment structure described by Welch and Frey we call this effect "false bottom effect". The echograph taken in October 1972 (fig. 4) shows two striking differences in comparison with that taken in June 1972:

1. There was no "false bottom effect" any more
2. We noticed lots of gas bubbles moving upwards in the central part of the lake

After Ohle (8, 9) this high content of gas in the recent sediment is due to fermentative secretion caused by micro-organisms which decompose the organic material that is moving down. This gas content prevents the echo sound from entering the sediment so that underlying layers cannot be detected. Also at the border between the water and the gas bubbles reflexion is extremely high and a clear second echo can be seen. On the profile taken in April 1973 (fig. 5) the "false bottom effect" is even more clearly noticeable than in the previous year (fig. 1). There is a close correlation between the occurrence of the "false bottom effect" and seasonal changes in the metabolism of the lake. After present studies the "false bottom effect" only occurs in those parts of lakes where the upper sediment layer is aerobic and the water layer directly above the sediment contains O_2 in relatively high concentrations. (We are in the process of carrying out further studies to quantify these O_2 concentrations. The "false bottom effect" disappears when emission of gas starts (due to decomposition of organic and inorganic material. At the same time the O_2 concentration in the hypolimnion decreases and sediment samples smell of H_2S). With the echo sounding for the first time aerobic and anaerobic areas in lakes could be detected and information on the O_2 situation in the hypolimnion was received. This information is used in regional studies of the metabolism of lakes in Sleswick-Holstein.

Summary

Investigations of the metabolism of lakes have to be based on exact studies on the shape of the lake basin.

There are no sufficient depth profiles for most of the lakes in Sleswick-Holstein. Sedimentation and land reclamation are increasing and a big danger especially for relatively small lakes. That makes studies on their morphology very urgent.

Profiles were taken with a 30 KHz echo sounder and were used as a basis for bathymetrical maps. Information was received on the morphology of the lake basin, on sedimentation and on O_2 metabolism near the sediment.

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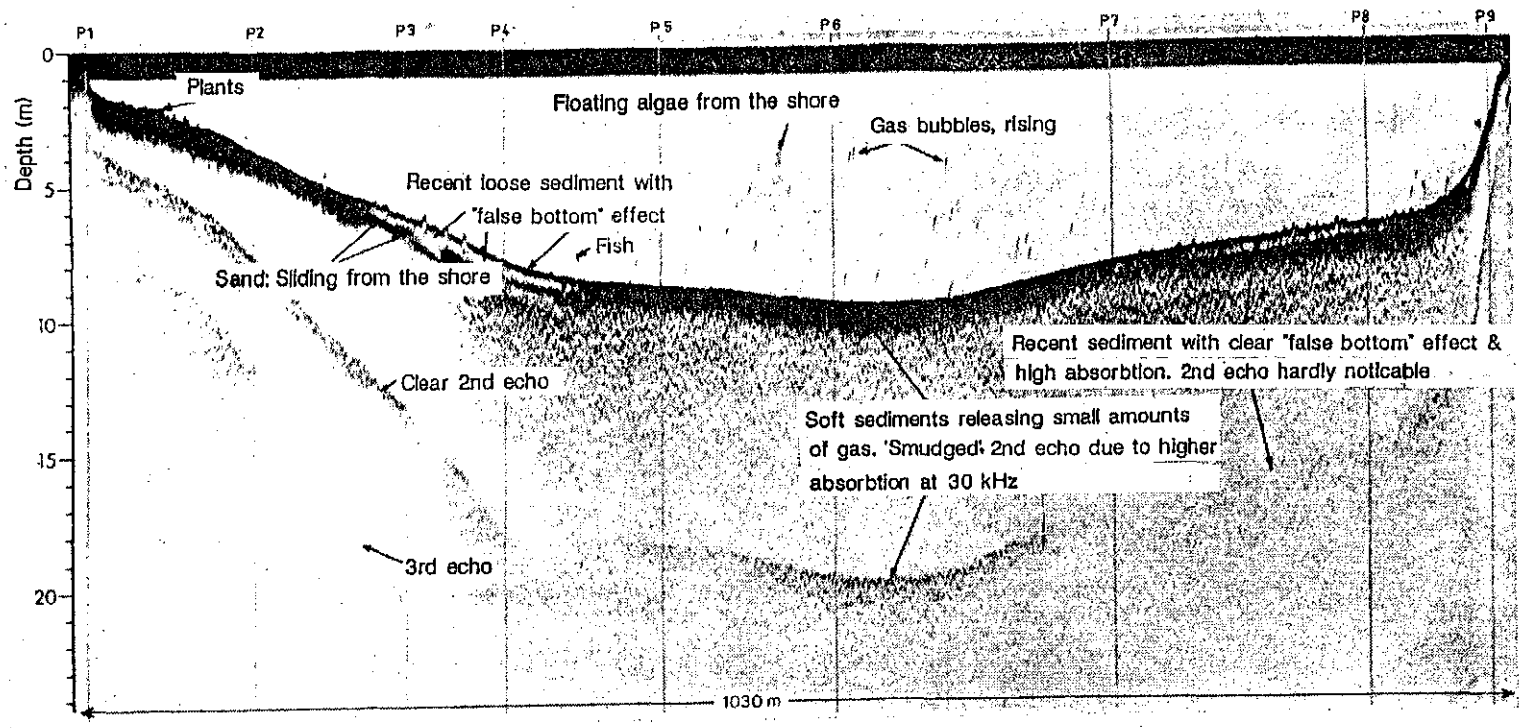

Figure I. Sediment-Echogramm of 'Blunker See'. Longitudinal Profile. Date; 29.6.1972.

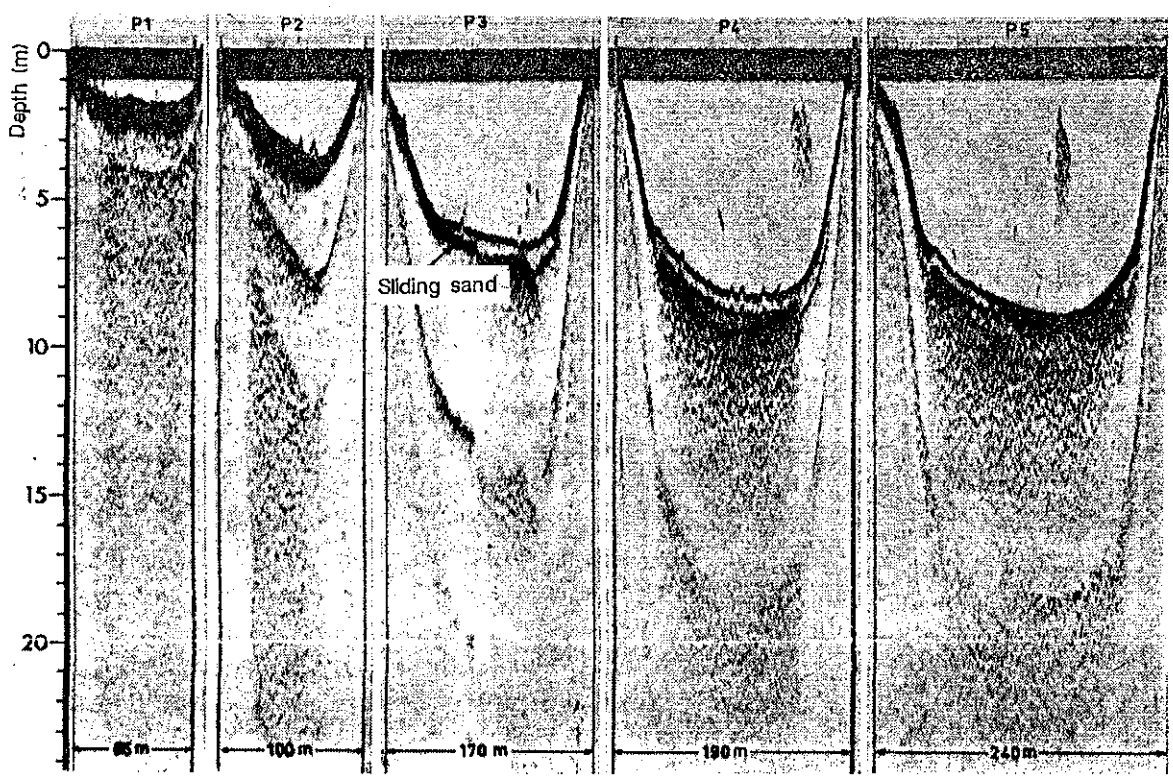

Figure 2. Sediment-Echogramm of 'Blunker See' Horizontal Profile. Date; 29.6.1972

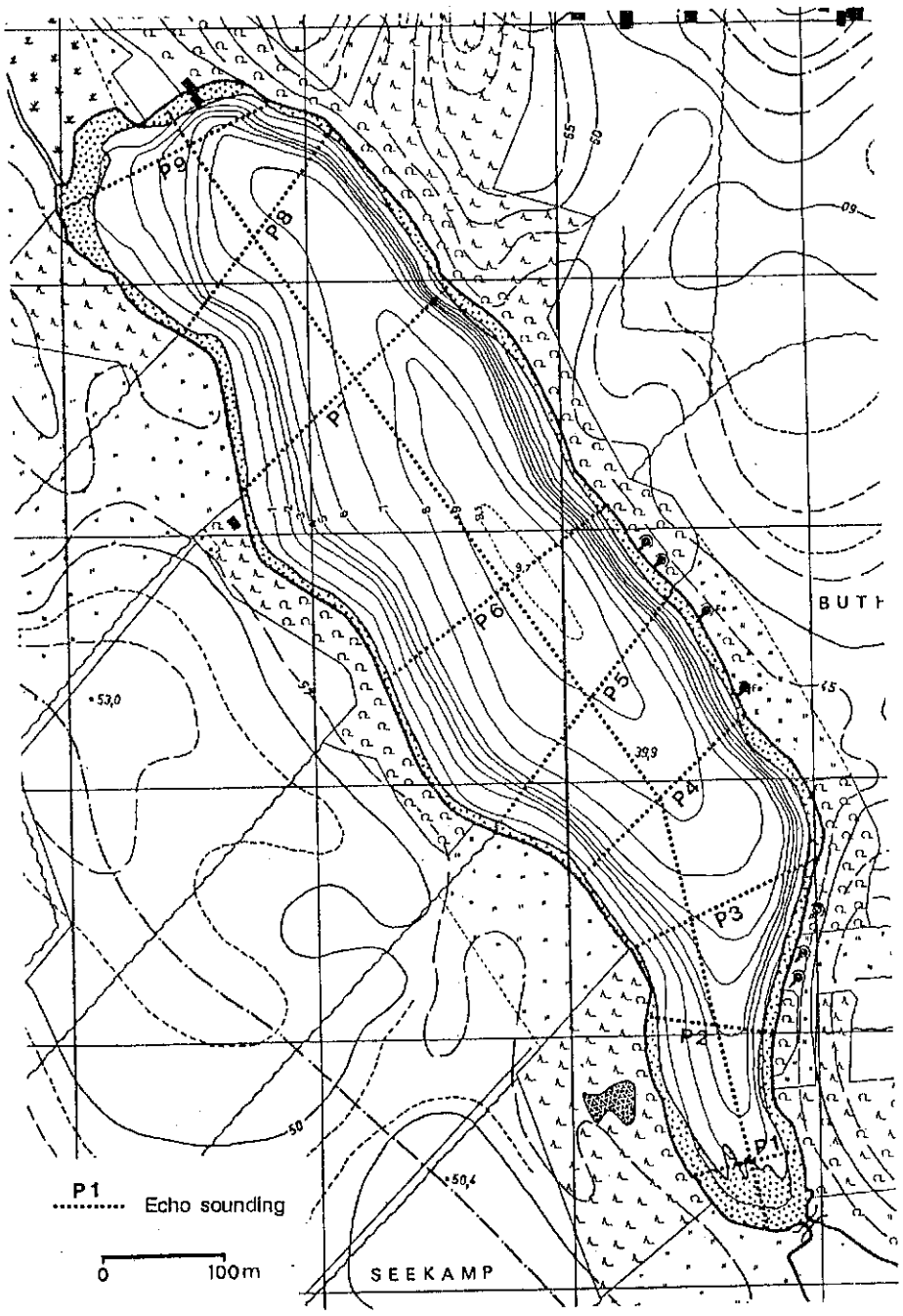

Figure 3. Bathymetrical Map of 'Blunker Sees'.

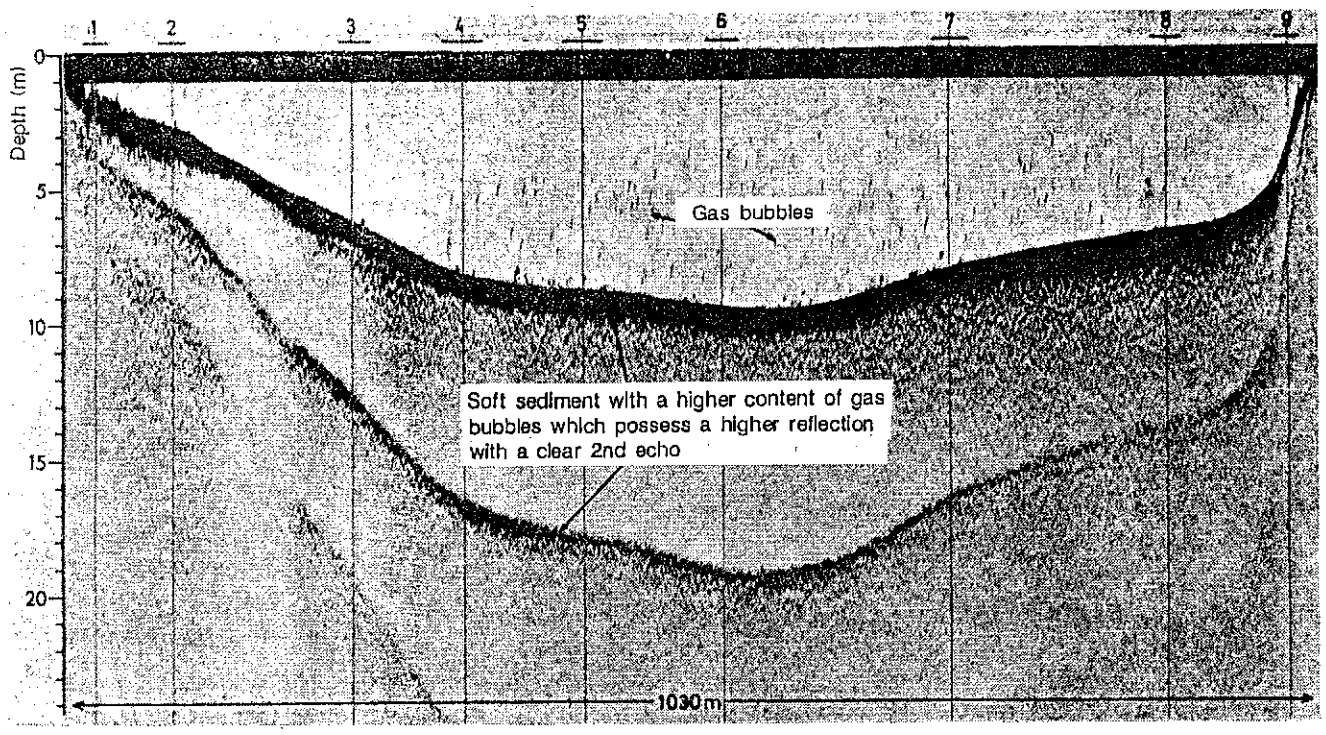

Figure 4. Sediment-Echogramm of 'Blunker See'. Longitudinal Profile. Date; II.IO.I972

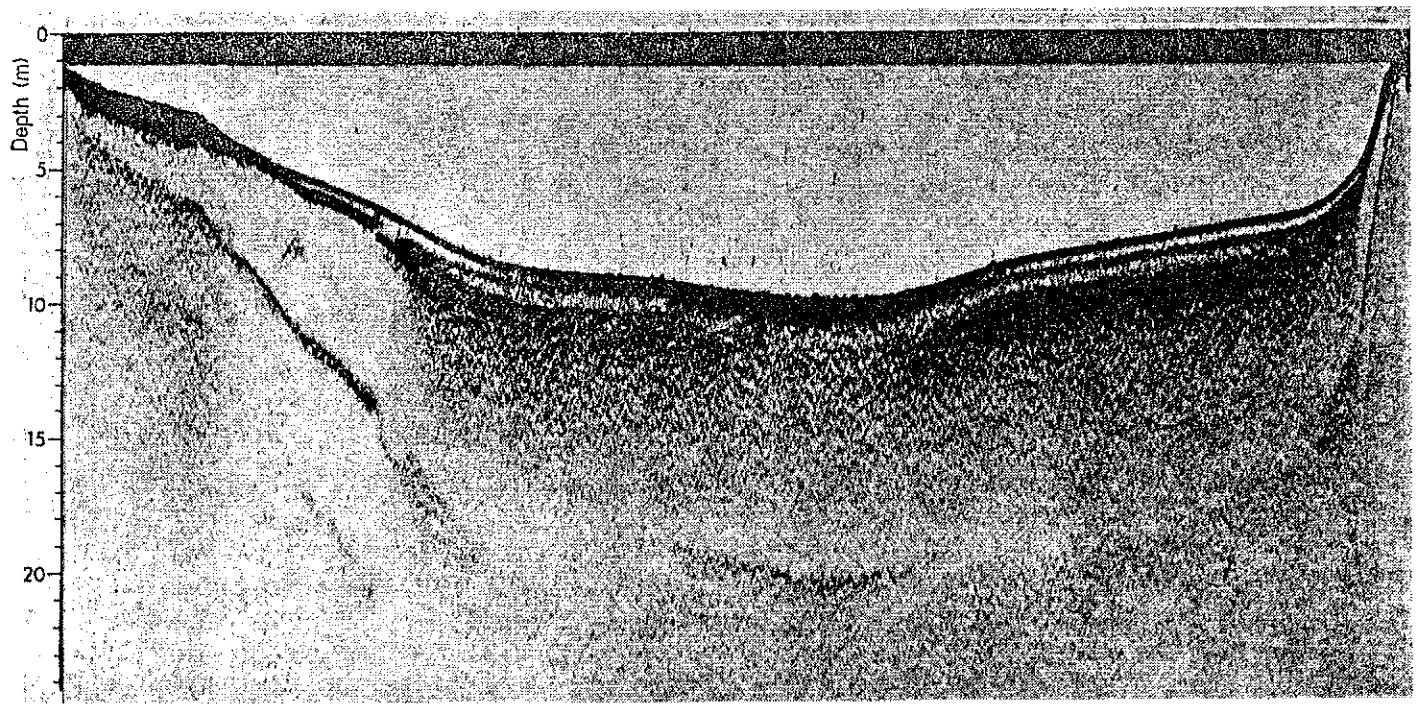

Figure 5. Sediment-Echogramm of 'Blunker-See'. Longitudinal Profile. Date; 24.4.I973

Notice

Please note that these translations were produced to assist the scientific staff of the FBA (Freshwater Biological Association) in their research. These translations were done by scientific staff with relevant language skills and not by professional translators.